TWO NEW EARLY CRETACEOUS DINOCYST SPECIES FROM THE NORTHERN NORTH SEA

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ABSTRACT. Two new species of dinocyst, *Oligosphaeridium abaculum* and *Systematophora silyba*, are described from a Barremian assemblage obtained from the northern North Sea north-east of the Shetlands. *O. abaculum* is the first-known hystrichosphere with plate-centred tubular processes on which a clearly defined paratabulation is present and this is described in detail. The paratabulation is of the *Gonyaulax*-type, and it is inferred that chorate cysts with similar morphology are also of this type.

DURING the routine dating of core samples from the Institute of Geological Sciences Offshore boreholes, a well-preserved and unusual dinocyst assemblage was recovered from the terminal depth sample (depth 78·95 m) of borehole 77/80B. Two new species from this assemblage are described below. The borehole was drilled during June 1977 and was located 30 km north-east of Unst, Shetlands in the northern North Sea licence block 1/4 (unallocated) at latitude 60° 56·7′ N., longitude 0° 15·7′ W. The water depth at this drilling site was 141 m. A sedimentary thickness of 78·95 m was penetrated which consisted of 33·60 m of Quaternary clay overlying 45·35 m of dark greenish-grey mudstone. The upper part of this mudstone is micropalaeontologically dated as being of Barremian–Aptian age and the lower part is of Barremian age.

All type and figured specimens having MPK numbers and the SEM stubs are housed in the collections of the Institute of Geological Sciences, Leeds.

ASSEMBLAGE DETAILS

After standard palynologic preparation, the core sample at 78·95 m yielded an assemblage composed almost entirely of dinocysts. Spores, pollen grains, and terrestrially derived plant debris are virtually absent. The dinocyst assemblage is very well preserved and dominated (97%) by *Oligosphaeridium abaculum* sp. nov. It, however, contains many other species including *Achomosphaera neptuni* (Eisenack 1958) Davey and Williams 1966*a*, *Avellodinium falsificum* Duxbury 1977, *Cassiculosphaeridia magna* Davey 1974, *Cyclonephelium hystrix* (Eisenack 1958) Sarjeant and Stover 1978, *Hystrichodinium voigtii* (Alberti 1961) Davey 1974, *Kleithriaspheridium corrugatum* Davey 1974, *Odontochitina operculata* (Wetzel 1933) Deflandre and Cookson 1955, *Phoberocysta neocomica* (Gocht 1957) Millioud 1969, *Pseudoceratium pelliferum* Gocht 1957, and *Systematophora silyba* sp. nov. This assemblage, but for the new species, closely resembles those obtained from the Barremian part of the Speeton Clay in north-east England (Davey 1974; Duxbury 1977). The presence of *O. operculata* together with *A. falsificum* and *K. corrugatum* indicates that this core sample is of early Barremian age and assignable to the *Cassiculosphaeridia magna* Subzone, *O. operculata* Zone of Davey in press[1].

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The relatively rich dinocyst assemblage, associated with the paucity of land-derived plant remains, strongly suggests that deposition at this borehole site during the early Barremian took place during a marine transgressive phase.

SYSTEMATIC DESCRIPTIONS

Class DINOPHYCEAE Fritsch
Order PERIDINIALES Haeckel
Genus OLIGOSPHAERIDIUM Davey and Williams 1966*b*

Remarks. O. abaculum sp. nov. is a tabulate dinocyst species, and by its inclusion in the previously non-tabulate genus *Oligosphaeridium* the concept of this genus, as envisaged by Davey and Williams 1966*b*, is widened. However, except for the paratabulation, *O. abaculum* is so similar to the other members of this genus that it is undoubtedly closely related to them and the paratabulation is considered to fall into the category of specific variation. The *Gonyaulax*-type paratabulation and process formula determined for this species can undoubtedly be applied to the other members of *Oligosphaeridium.* In addition, it is probable that morphologically similar genera such as *Hystrichosphaeridium* Deflandre 1937 emend. Davey and Williams 1966*b*, *Kleithriasphaeridium* Davey 1974, and *Systematophora* Klement 1960 also have the same paratabulation.

Oligosphaeridium abaculum sp. nov.

Plate 48, figs. 1–6; Plate 49, figs. 1–7; Plate 50, figs. 1, 4, 10, 11; text-figs. 1, 2

Derivation of name. Latin, *abaculus*, small tile for mosaic work, with reference to the tabulate nature of the cyst wall.

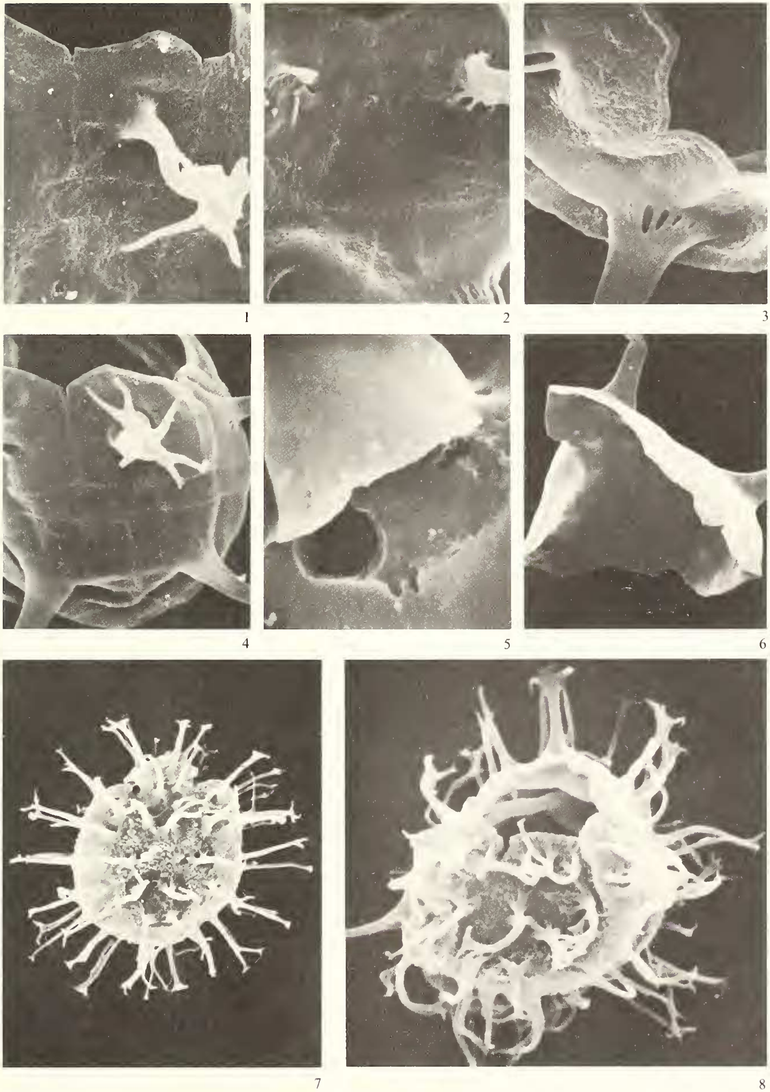
Diagnosis. Shape: the pericyst, excluding processes, was originally spheroidal with only minor dorso-ventral flattening.

Wall: the cyst wall is apparently two-layered, the two layers being closely appressed except where the periphragm alone forms the processes. The wall is lightly to densely intraperforate, the surface is smooth to scabrate and sparsely pitted. The processes are smooth.

EXPLANATION OF PLATE 48

Figs. 1–6. *Oligosphaeridium abaculum* sp. nov. Note variation in cyst wall texture from smooth to scabrate. 1, offset ventral view with process arising from paraplate 6″. The wall is sparsely pitted and the parasutures very faintly indicated, ×1500 (SEM). 2, lateral view; the precingular process has a strongly perforate base and on the adjacent paraplate (upper left) the precingular process has become completely detached at this point. Parasutures defined by very low ridges, ×1400 (SEM). 3, view of archaeopyle margin and base of precingular process, ×5000 (SEM). 4, lateral view illustrating strong parasutural ridges and the distal spines of a precingular process, ×1000 (SEM). 5, view of base of a partially detached process, ×10,000 (SEM). 6, cyst fragment illustrating smooth internal wall, ×2000 (SEM).

Figs. 7, 8. *Systematophora silyba* sp. nov. 7, lateral view of specimen with operculum remaining partially attached. Note the alignment of cingular processes dividing the cyst into approximately equal halves. The pre- and postcingular annulate complexes are particularly noticeable because of the smooth periphragm surrounding, and within, each complex, ×1500 (SEM). 8, apical-lateral view of specimen with archaeopyle to illustrate the structure of a precingular annulate complex, ×2000 (SEM).



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Paratabulation: the parasutures may be defined by very low ridges or by an apparent change in the internal wall structure; the clarity of the parasutures varies from poor to good with those in the parasulcal region being the most poorly defined. The paratabulation formula is pr, 4′, 6″, 6c, 6‴, 1p, 5s, 1⁗.

Processes: the processes are of tubiform shape, and flare distally typically giving rise to six slight flexuous spines; neighbouring spines may be joined medially to each other. Process stem width varies according to position on the cyst, with the apical, posterior, intercalary, and parasulcal processes being the most narrow. These processes are also the shortest but variation in length is not pronounced; process length is approximately equal to half the endocyst diameter. The process formula is 4′, 6″, 5‴, 1p, 1s, 1⁗; the first postcingular paraplate (1‴) does not bear a process and the parasulcal process occurs on the posterior sulcal paraplate (ps).

Archaeopyle: a apical archaeopyle always appears to be present, and is developed by the detachment of the apical paraplates as a unit (type $\bar{A}$). It has a strongly zigzag margin with a deep parasulcal notch.

Holotype. MPK 2145, slide CSC 1824/4, IGS borehole 77/80B, depth 78·95 m, northern North Sea, block 1/4. Barremian.

Paratype. MPK 2146, slide CSC 1824/4. IGS borehole 77/80B, depth 78·95 m, northern North Sea, block 1/4. Barremian.

Dimensions

	Holotype (μm)	Paratype (μm)	Range (μm)
Pericyst diameter (excluding processes)			
length (archaeopyle developed)	54	—	51(56)62
width	57	52	52(57)64
Process stem length	28–36	22–38	16–38 (av. max. 31)

Number of specimens measured 15.

Description. Wall: the pericyst wall is approximately 0·5 μm thick and is not obviously two-layered. The density of the intraperforation varies only slightly with the individual and the consequent spongy appearance is obvious under the light microscope (Pl. 50, figs. 10, 11); under the SEM the wall surface is smooth to very lightly pitted (Pl. 48, figs. 1–6). The parasutures are immediately obvious under the light microscope but under the SEM are difficult (Pl. 48, figs. 1, 2), and sometimes impossible, to discern. Rarely do they take the form of low ridges (Pl. 48, fig. 4). This lack or paucity of surface expression suggests that the parasutural markings may be mainly features formed by a change in wall structure such as a marked decrease in wall intraperforation.

EXPLANATION OF PLATE 49

Figs. 1–7. *Oligosphaeridium abaculum* sp. nov. All figures ×300. 1, ventral view of holotype. 2, view of posterior part of the parasulcus. Note that processes have been detached from paraplates ps and lp. Slide CSC 1824/4, MPK 2160, phase contrast. 3, dorsal view of the holotype. 4, detached operculum; note centrally situated preapical paraplate. Slide CSC 1824/4, MPK 2161. 5, lateral view of specimen illustrating the shape of the cingular paraplates. Slide CSC 1824/4, MPK 2162, phase contrast. 6, antapical view of paratype. 7, lateral view of specimen illustrating the spinose distal extremities of the processes. Slide CSC 1824/4, MPK 2163, interference contrast.

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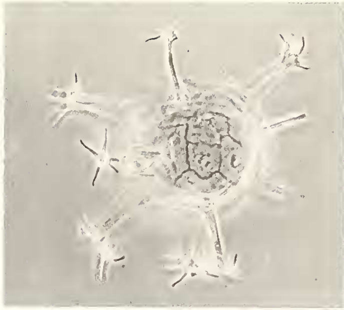

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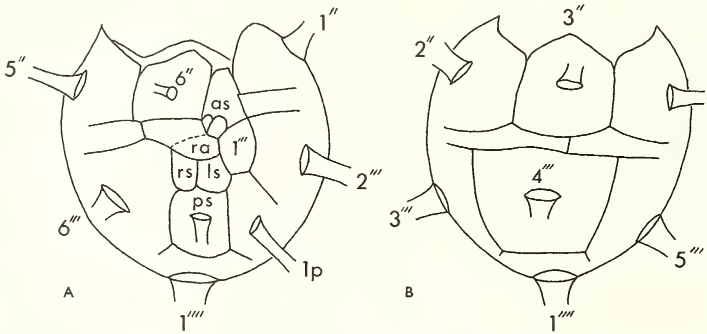
Processes: the processes are smooth, without internal wall structure and the wall thickness is less than 0·5 μm. Proximally, the bases of the processes typically have small to relatively large perforations (Pl. 48, figs. 2, 3). When these are well developed a definite weakness of the process wall is developed and the process easily becomes broken at this point (Pl. 48, fig. 5; Pl. 49, figs. 2, 5).

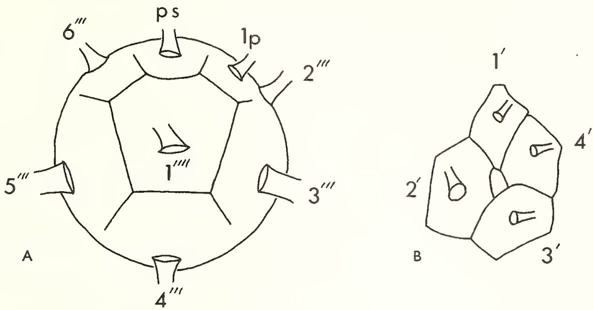
Paratabulation: the epicyst and hypocyst are of approximate equal size and are separated by a narrow paracingulum which on the ventral surface, is displaced by its own width (text-fig. 1A). The ends of the paracingulum do not overlap. The parasulcus is not sinusoidal but is rather displaced approximately half its width to the left at the paracingulum. The sulcal paraplates as, rs, ls, and ps are well defined; as is large and elongate, rs and ls are small and rectangular, and ps is relatively large and rectangular. The latter has a semi-circular boundary with paraplate 1''''. Paraplate ra lies above paraplates rs and ls and to the right of 1'''; its boundary with cingular paraplate 6c is poorly defined. At the posterior end of paraplate as, abutting against paraplates 6c, ra and 1''', are two depressions which correspond to the thecal flagellar pores. The right depression is the smaller and more deeply indented.



TEXT-FIG. 1. Drawings of the holotype of *Oligosphaeridium abaculum* sp. nov. to illustrate the paratabulation and the position of the processes (process terminations omitted). A, ventral surface. as, anterior sulcal; ra, right accessory; rs, right sulcal; ls, left sulcal; ps, posterior sulcal paraplates. B, dorsal surface.

A small ovoidal preapical paraplate (pr) occupies the centre of the apical series (text-fig. 2B). The apical paraplates 1' and 4' are essentially four-sided with 1' having an additional small side that abutts against paraplate as. Paraplates 2' and 3' are basically five-sided. The precingular paraplates are five-sided with 6'' being the smallest. The elongate cingular paraplates have arcuate long margins and are narrowest at the cingular paraplate boundaries and widest, particularly on the dorsal surface (text-fig. 1B), where the precingular parasutures abutt against them. The postcingular paraplates are large and basically rectangular except for 1''' which is small, rectangular, and occurs beneath as and above 1p. The latter is five-sided. The antapical paraplate (1'''') is basically five-sided with paraplate ps indenting its ventral margin (text-fig. 2A).

Intraspecific variation: this is slight and involves details such as process length, width, and clarity of paratabulation. However, one rare distinctive variant exists in which the stems of the processes are very short or apparently absent (Pl. 50, figs. 1, 4). In the latter case, the stellate distal process terminations lie directly on the endocyst.



TEXT-FIG. 2. Drawing of *Oligosphaeridium abaculum* sp. nov. to illustrate the paratabulation and the position of the processes (process terminations omitted). A, antapical view of paratype. B, detached operculum (MPK 2161). Note small preapical paraplate occupying the centre of the apical series.

Remarks. The more or less clear paratabulation of *O. abaculum* sp. nov., which is defined by low ridges or, more usually, by internal wall structuring, differentiates this species from all previously described species. Davey, in press[2], erected a granular species of *Oligosphaeridium*, *O. verrucosum*, from the Aptian of the northern Bay of Biscay which sometimes possesses smooth parasutural areas. However, the granular nature of the periphragm and the form of the paratabulation differentiates *O. verrucosum* from *O. abaculum*. Evitt *et al.* (1977, p. 4) record that Wiggins and Engelhardt have found tabulate specimens of *Oligosphaeridium* in the Lower Cretaceous of Alaska; it may be that these are comparable to the present species.

Genus SYSTEMATOPHORA Klement, 1960

Systematophora silyba sp. nov.

Plate 48, figs. 7, 8; Plate 50, figs. 2, 3, 5, 6, 7–9

Derivation of name. Latin, *silybum*, a kind of thistle—with reference to the spiny appearance of the cyst.

Diagnosis. Shape: the pericyst, excluding processes, is subspherical to ovoidal, the long axis being in the apical-antapical plane. Dorso-ventral flattening is minor.

Wall: the cyst wall is apparently two-layered, the two layers being closely appressed except where the periphragm alone forms the processes. The pericyst surface is rarely smooth and is typically densely granular; the granules are concentrated in the paracingular and pandasutural areas.

Processes: the processes are solid and smooth walled. Distally they terminate with an irregular bifurcation; proximally they may divide several times before joining the endocyst. Rarely neighbouring processes may be linked medially or distally. They vary in width but are approximately of equal length—typically between one quarter and one third the endocyst diameter. The processes are aligned along the paracingulum, and in the pre- and postcingular and antapical regions tend to form annulate complexes.

Archaeopyle: an apical archaeopyle (type Ā) always appears to be developed although the operculum often remains attached. The archaeopyle has a strongly zigzag margin with a moderately deep parasulcal notch.

Holotype. MPK 2147, slide CSC 1824/3, IGS borehole 77/80B, depth 78·95 m, northern North Sea, block 1/4. Barremian.

Paratype. MPK 2148, slide CSC 1824/4, IGS borehole 77/80B, depth 78·95 m, northern North Sea, block 1/4. Barremian.

Dimensions

	Holotype (μm)	Paratype (μm)	Range (μm)
Pericyst diameter (excluding processes)			
length (complete)		36	36–38
length (archaeopyle developed)	33	—	30(32)36
width	38	33	29(34)38
Process length	8–14	7–10	7–14 (av. max. 13)

Number of specimens measured 15.

Description. Wall: the pericyst wall is approximately 0·5 μm in thickness. Smooth specimens are apparently present and although the majority of specimens are strongly granular (Pl. 48, figs. 7, 8), the exact nature of the surface ornamentation is sometimes difficult to discern under the light microscope. The granules, which measure less than 0·5 μm in diameter, vary somewhat in size and appear to be restricted to the portions of the cyst surface outside the annulate complexes. This unusual distribution results

EXPLANATION OF PLATE 50

Figs. 1, 4, 10, 11. *Oligosphaeridium abaculum* sp. nov. 1, ventral view to specimen with very faint parasutures and reduced process stems, ×2000 (SEM). 4, dorsal view of similar aberrant specimen with more clearly defined paracingulum, ×1500 (SEM). 10, 11, Slide CSC 1824/1, MPK 2164. Ventral views of specimen to illustrate wall texture and structure, 10, ×800 (interference contrast); 11, ×800 (plase contrast).

Figs. 2, 3, 5, 6, 7–9. *Systematophora silyba* sp. nov. 2, dorsal view of holotype illustrating pre- and postcingular annulate complexes and aligned cingular processes, ×640. 3, ventral view. Slide CSC 1824/4, MPK 2165, ×640. 5, medial view of paratype, ×640. 6, dorsal view of paratype, ×640. 7, detail of cyst surface to illustrate smooth processes and granular surface periphragm, ×5000 (SEM). 8, lateral view of a particular granular specimen; operculum partially attached. Slide CSC 1824/4, MPK 2166, ×640. 9, lateral view of specimen illustrating process alignment and archaeopyle development. Slide CSC 1824/1, MPK 2167, ×640.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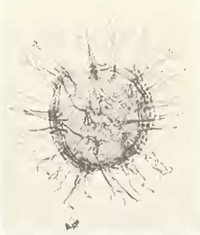
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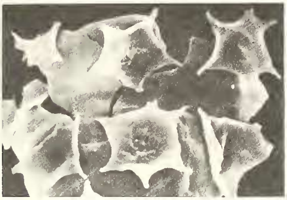
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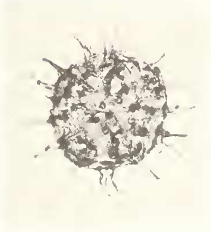
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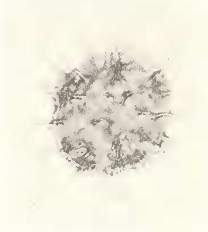
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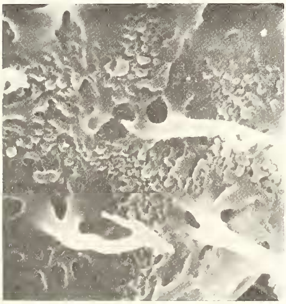
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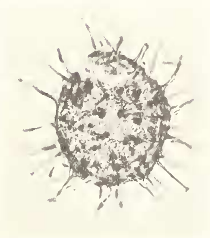
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because the smooth walled processes tend to branch proximally to give root-like extensions over the cyst surface within the annulate complexes (Pl. 48, figs. 7, 8). A less well defined, non-granulate area sometimes surrounds the complexes and similarly results from the proximal branching of the processes. The processes vary in width from under 0·5 μm to 2 μm, are mainly either bifid distally or are broadly but irregularly capitate.

Process distribution: the epicyst and hypocyst are of approximate equal size and are separated by a single alignment of processes that mark the position of the paracingulum. They are here distributed in pairs and triplets, each linear group being indicative of a single cingular paraplate. Annulate complexes occupy the pre- and postcingular and antapical regions and each indicates a single paraplate. There appear to be six precingular, five postcingular, and one antapical complex. Obvious annulate complexes or process alignments are absent in the apical and parasulcal regions.

Remarks. The combination of apical archaeopyle and annulate process complexes clearly indicate that *S. silyba* sp. nov. belongs to the genus *Systematophora.* The simple form of the processes, however, differentiates this species from most other members of the genus, which bear complexly branching and anastomozing processes. *S. areolata* Klement 1960, from the Upper Jurassic, is the most similar species but differs significantly in having fewer processes which are more orderly arranged; in particular, the annulate complexes are very obvious.

The specimen illustrated by Duxbury 1977 (pl. 11, fig. 3) as *Cleistosphaeridium polypes* (Cookson and Eisenack 1962), from the Hauterivian and Barremian of north-east England, is similar to *S. silyba* and may be conspecific.

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REFERENCES

ALBERTI, G. 1961. Zur Kenntnis mesozoischer und alttertiärer Dinoflagellaten und Hystrichosphaerideen von Nord- und Mitteldeutschland sowie einigen anderen Europäischen Gebieten. *Palaeontographica*, A, **116**, 1–58, pls. 1–12.

COOKSON, I. C. and EISENACK, A. 1962. Additional microplankton from Australian Cretaceous sediments. *Micropaleontology*, **8**, 485–507, pls. 1–7.

DAVEY, R. J. 1974. Dinoflagellate cysts from the Barremian of the Speeton Clay, England. *In* Symposium on Stratigraphic Palynology, *Birbal Sahni Institute of Palaeobotany*, Special Pub. No. 3, 41–75, pls. 1–9.

—— in press[1]. The stratigraphic distribution of dinocysts in the Portlandian (latest Jurassic) to Barremian (Early Cretaceous) of north-west Europe. *Amer. Assoc. Strat. Palynol.* Contrib. Ser., pls. 1–4.

—— in press[2]. Marine Apto-Albian palynomorphs from Sites 400A and 402A, IPOD Leg 48, northern Bay of Biscay. *Initial Reports of the Deep Sea Drilling Project*, **48**, pls. 1–8.

—— and WILLIAMS, G. L. 1966*a*. The genera *Hystrichosphaera* and *Achomosphaera*. *In* Studies on Mesozoic and Cainozoic dinoflagellate cysts. *Bull. Br. Mus. nat. Hist.* (Geol.), suppl. **3**, 28–52.

—— —— 1966*b*. The genus *Hystrichosphaeridium* and its allies. *In* Studies on Mesozoic and Cainozoic dinoflagellate cysts. Ibid. 53–106.

DEFLANDRE, G. 1937. Microfossiles des silex crétacés. Deuxième partie. Flagellés *incertae sedis* Hystrichosphaeridés. Sarcodonés. Organisms divers. *Ann. Paléont.* **26**, 51–103, pls. 11–18.

DEFLANDRE, G. and COOKSON, I. E. 1955. Fossil microplankton from Australian late Mesozoic and Tertiary sediments. *Aust. J. Mar. Freshwat. Res.* **6,** 242–313, pls. 1–9.

DUXBURY, S. 1977. A palynostratigraphy of the Berriasian to Barremian of the Speeton Clay of Speeton, England. *Palaeontographia*, B, **160,** 17–67, pls. 1–15.

EISENACK, A. 1958. Mikroplankton aus dem norddeutschen Apt. *Neues Jb. Geol. Paläont., Abh.*, **106,** 383–422, pls. 21–27.

EVITT, W. R., LENTIN, J. K., MILLIOUD, M. E., STOVER, L. E. and WILLIAMS, G. L. 1977. Dinoflagellate cyst terminology. *Pap. geol. Surv. Can.* **76-24,** 1–9.

GOCHT, H. 1957. Mikroplankton aus dem nordwestdeutschen Neokom (Teil 1). *Paläont. Z.* **31,** 163–185, pls. 18–20.

KLEMENT, K. W. 1960. Dinoflagellaten und Hystrichosphaerideen aus dem unteren und mittleren Malm Südwestdeutschlands. *Palaeontographica*, A, **114,** 1–104, pls. 1–10.

MILLIOUD, M. E. 1969. Dinoflagellates and acritarchs from some western European Lower Cretaceous type localities. *In* BRONNIMANN, P. and RENZ, H. H. (eds.). *Proceedings First International Conference Planktonic Microfossils, Geneva, 1967*, **2,** 420–434, pls. 1–3, E. J. Brill, Leiden.

SARJEANT, W. A. S. and STOVER, L. E. 1978. *Cyclonephelium* and *Tenua*: A problem in dinoflagellate cyst taxonomy. *Grana*, **17,** 47–54.

WETZEL, O. 1933. Die in organischer Substanz erhaltenen Mikrofossilien des baltischen Kreide-Feuersteins mit einem sediment-petrographischen und stratigraphischen Anhang. *Palaeontographica*, A, **77,** 141–188.

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